

CALIFORNIA OCCUPATIONAL GUIDES



MACHINISTS AND NUMERICAL CONTROL TOOL PROGRAMMERS



WHAT DO MACHINISTS AND NUMERICAL CONTROL TOOL PROGRAMMERS DO?

MACHINISTS AND NUMERICAL CONTROL (NC) TOOL PROGRAMMERS make precision metal or plastic parts. Increasingly, they use computer numerically controlled machine tools to do their work.

Machinists

Machinists use machine tools, such as lathes, drill presses, and milling machines to produce precision metal parts. Although they may produce large quantities of one part, precision Machinists often produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with machine tools to plan and carry out the operations needed to make machined products that meet precise specifications.

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Machinists perform the following tasks:

- Set up and operate all of the basic machine tools and many specialized or advanced variations.
- Handle a metalworking project from planning and fabrication through assembly, inspection, and testing.
- Review blueprints, written specifications, or descriptions.
- Examine damaged parts.
- Select the most appropriate machines, cutting tools, and materials for the job.
- Plan the sequence of machining operations.
- Make required mathematical calculations.
- Lay out and mark metal stock to show where cuts should be made.
- Position and fasten the work piece.
- Mount the correct type of cutting tool.
- Perform required operations of the equipment.

Specifications often require tolerances (high precision) of thousandths or even ten-thousandths of an inch. After completing the machining operations, Machinists may finish, fit, and assemble the final part.

Maintenance Machinists overhaul and renovate equipment and machinery. They diagnose equipment malfunctions and repair or fabricate new parts, using NC or mechanical machine tools and metalworking techniques. They may also install new equipment.

Experimental or Prototype Machinists assist designers and engineers in developing new products and production processes. Working from rough engineering sketches or verbal instructions, these Machinists use their experience and ingenuity to devise practical methods to produce experimental tooling and parts and to build complete working prototype models for testing.

Numerical Control Tool Programmers

The introduction of computer numerically controlled machine tools has changed the nature of the work of Machinists. The quality of the products these tools produce depends largely on the programs, which are produced by NC Tool Programmers. These workers perform the following tasks:

- Prepare geometric layout from graphic displays, using computer-assisted drafting (CAD) software or drafting instruments and graph paper.
- Write instruction sheets, cutter lists, and machine instructions programs to guide set-up and encode numerical control tape.
- Analyze drawings, specifications, printed circuit board pattern film, and design data to calculate dimensions, tool selection, machine speeds, and feed rates.
- Determine reference points, machine cutting paths, or hole locations and compute angular and linear dimensions, radii, and curvatures.
- Compare encoded tape or computer printout with original program sheet to verify accuracy of instructions.
- Draw machine tool paths on pattern film, using colored markers and following guidelines for tool speed and efficiency.
- Revise numerical control machine tape programs to eliminate instruction errors and omissions.
- Enter computer commands to store or retrieve parts patterns, graphic displays, or programs to transfer data to other media.
- Align and secure pattern film on reference table of optical programmer and observe enlarger scope view of printed circuit board.
- Move reference table to align pattern film over circuit board holes with reference marks on enlarger scope.
- Depress pedal or button of programmer to enter coordinates of each hole location into program memory.
- Load and unload disks or tapes and observe operation of machine on trial run to test taped or programmed instructions.

- Review shop orders to determine job specifications and requirements.
- Sort shop orders into groups to maximize materials utilization and minimize machine setup.
- Test program through simulation.

Skilled Machinists often also do NC programming. In fact, as computer-aided manufacturing (CAM) software becomes easier to understand and NC machines are more widely used, Machinists are increasingly expected to perform this function.

WHAT SKILLS ARE IMPORTANT?

Important skills, knowledge, and abilities for Machinists and NC Tool Programmers include:

- Operations Analysis – Analyzing needs and product requirements to create a design.
- Quality Control Analysis – Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
- Programming – Writing computer programs for various purposes.
- Mathematics – Using mathematics to solve problems.
- Computers and Electronics – Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Mechanical – Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
- Design – Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Control Precision – The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.
- Visualization – The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.

- Information Ordering – The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

WHAT'S THE WORK ENVIRONMENT?

Most machine shops are relatively clean, well lighted, and well ventilated. However, without the proper safety precautions such as earplugs, facemasks, and safety glasses the job can be noisy and hazardous. Without protection, possible hazards are flying metal chips, abrasive dust, sharp cutting tools, and moving parts.

Union Membership

Many of these workers are members of unions. Depending on the type and location of the employer, these workers may belong to the International Association of Machinists and Aerospace Workers or other labor organizations.

WHAT'S THE CALIFORNIA JOB OUTLOOK?

The following information is from the occupational projections produced by the Employment Development Department (EDD) Labor Market Information Division (LMID):

Machinists

Estimated number of workers in 2000:	47,900
Estimated number of workers in 2010:	52,100
Projected Growth 2000-2010:	8.8%
Est. openings due to separations by 2010:	10,300

These figures do not include self-employment.

The Machinist occupation will grow slower than average compared with all occupations in California.

Numerical Tool and Process Control Programmers

Estimated number of workers in 2000:	2,300
Estimated number of workers in 2010:	2,600
Projected Growth 2000-2010:	13%
Est. openings due to separations by 2010:	900

These figures do not include self-employment.

The Numerical Control Tool Programmers occupation will grow slower than average compared with all occupations in California.

Trends

There will be fewer new jobs for Tool Programmers as more firms now use ready-made software or require Machinists to use CAD systems to write programs. While a slower than average growth rate is projected for Machinist jobs, many employers report difficulty in finding skilled workers for machining and tool programming positions. Over 15,000 workers will leave this kind of work permanently by 2010, creating opportunities for workers entering the field who have mechanical aptitude, computer skills, and mathematical ability.

WHAT DOES THE JOB PAY?

California Earnings

Machinists 2002 Wages

Hourly wages range from	\$10.97	to	\$21.11
Average hourly wage	\$16.59		
Average annual wage	\$34,507		

Numerical Tool and Process Control Programmers 2002 Wages

Hourly wages range from	\$16.48	to	\$26.61
Average hourly wage	\$22.25		
Average annual wage	\$46,278		

Source: Occupational Employment Survey of Employers by EDD/LMID.

Hours

Although most machine tool jobs are day shift, Machinists and Tool Programmers may work on any of three eight-hour shifts. Evening and night shift workers normally receive higher pay. A forty-hour, five-day workweek is normal.

Benefits

Benefits almost always include vacation and sick leave, health and life insurance, and retirement plans.

HOW DO I PREPARE FOR THE JOB?

Education and Training

The best preparation for Machinists is a formal apprenticeship program offered through local

unions, which includes full-time work, on-the-job training, and job-related classroom instruction. Use of computer-controlled machine tools is common, so basic computer and electronics courses are also needed. Most apprenticeship programs are four years in length and lead to all-around journey-level status. Some two-year apprenticeships are also available, leading to specialist Machinist jobs. Apprentice applicants usually must be at least 18 years old and have a high school diploma or qualifying scores on the General Educational Development (GED) or the California Proficiency Test.

High school or vocational school courses should include mathematics, blueprint reading, computer courses, metalworking, and drafting.

Training in machine tool technology is available at community colleges, private trade/technical schools, and Regional Occupational Programs (ROP) which are operated by high school districts throughout the State.

Machinists and Tool Programmers need mechanical aptitude, manual dexterity, and visual acuity. Additionally, skilled workers must be able to work independently and be suited to do exacting work that requires close and continuous concentration. Journey-level Machinists and specialist Machinists are usually expected to have their own hand tools and precision measuring instruments. Most machine shops supply tools for new workers to use until they can purchase their own sets.

Continuing Education

As machine tools change in their complexity and make-up, Machinists and NC Tool Programmers must learn new skills to keep abreast of the changes. Programming courses, plus courses offered by machine tool manufacturers, are needed to keep workers skills current.

HOW DO I FIND THE JOB?

Direct application to employers or unions remains one of the most effective job search methods. Private firms are listed in the yellow pages under Machine Shops, Machine Tools, and Machinery-Repairing. California job openings can be found

at various online job-listing systems including CalJOBSSM at www.caljobs.ca.gov or at America's Job Bank at www.ajb.dni.us.

For other occupational and wage information and a listing of the largest employers in any county, visit the Employment Development Department Labor Market Information Web page at www.calmis.ca.gov. Find further job search assistance from your nearest Job Service office www.edd.ca.gov/jsloc.htm or the closest One-Stop site listed on the California WorkNet site, www.sjtcc.ca.gov/sjtccweb/one-stop.

WHERE CAN THIS JOB LEAD?

Experienced Machinists can advance to Machine Tool Programmers, to supervisory or administrative positions in their firms, or may open their own shops. In some machine shops, experienced Machinists are eligible to participate in employer-sponsored skills upgrading programs and progress to full journey-level status.

OTHER SOURCES OF INFORMATION

CA Division of Apprenticeship Standards
For the closest district office, visit
www.dir.ca.gov/DAS/das.html,
or call Apprenticeship Standards
Information listed in your telephone
directory business white pages

National Tooling and Machining
Association (NTMA)
9300 Livingston Road
Ft. Washington, MD 20744
(800) 248-6862
www.ntma.org

Employment Projections by Occupation
www.calmis.ca.gov/htmlfile/subject/occproj.htm

Employment and Wages by Occupation
[www.calmis.ca.gov/file/occup\\$/OES\\$.htm](http://www.calmis.ca.gov/file/occup$/OES$.htm)

RELATED OCCUPATIONAL GUIDES

Tool and Die Makers	No. 15
Sheet Metal Workers	No. 49
Welders	No. 84
Metal Workers (Field and Shop Ironworkers)	No. 112
Numerical Control Machine Operators	No. 548

OCCUPATIONAL CODE REFERENCES**SOC** (*Standard Occupational Classification*)

Numerical Tool and Process Control	
Programmers	51-4012
Machinists	51-4041

O*NET (*Occupational Information Network*)

Numerical Tool and Process Control	
Programmers	51-4012.00
Machinists	51-4041.00

OES (*Occupational Employment Statistics*)

Programmers, Numerical, Tool, and	
Process Control	25111
Machinists	89108

DOT (*Dictionary of Occupational Titles*)

Tool Programmer, Numerical Control	007.167-018
Machinist, Experimental	600.260-022
Machinist	600.280-022
Maintenance Machinist	600.280-042